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NITROSTARCH SLURRY AS A BLASTING AGENT FOR SNOW SAFETY WORK

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A type of high explosive known as nitrostarch slurry has recently become available and has been suggested on several occasions as suitable for snow safety operations such as avalanche blasting. The basic explosive ingredient of this compound is nitrostarch, which is combined with certain other elements and a gelling agent. (The exact composition is a trade secret.) The gelling agent sets up to a plastic-like consistency about 24 hours after mixing. The result is an explosive compound with the consistency of moist, soft clay. It can be readily molded to any desired shape. It is packaged for sale in polyethylene bags which can be readily shaped for application. This explosive is sold primarily as an agent for mud-capping and similar applications and is reported to be effective for such use.

Nitrostarch slurry is a stable explosive unaffected by low temperatures. It may be stored for long periods with no deterioration. Long storage or very low temperatures may cause a slight stiffening (reduced plasticity) but this does not affect safety or explosive properties. Nitrostarch slurry does not contain nitroglycerin or other unstable constituents. It cannot be detonated by a blasting cap, nor by primacord. It requires a PETN booster for detonation, and thus is comparable in sensitivity to military explosives like tetrytol. It is not as stable as ammonium nitrate.

We have conducted field tests with the nitrostarch slurry marketed by the Trojan Powder Company under the trade name of "Plastimite."* This product is available in Salt Lake City packaged in 2, 3, 5 and 10-lb. plastic bags.

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*These tests do not constitute an endorsement of this particular product. Similar products by other manufacturers may be used as well.

The current price of these packages, complete with PETN booster and about a 1-ft. lead of E-cord (slender primacord), are as follows:
2 lbs.--$0.50, 3 lbs.--$0.65, 5 lbs.--$1.00, and 10 lbs.--$1.75.
Our tests were conducted with the 2-lb. bags.

In order to test stability, a 2-lb. bag of Plastimite was set up as a target 50 yards away for a 30-30 rifle (nominal muzzle velocity 2400 ft./sec.). Impact of the bullet scattered about half the contents for 30 ft. in all directions, but caused no detonation.

A 1-oz. piece of Plastimite was tossed on a briskly burning fire. It burned with reluctance.

A 2-lb. bag of Plastimite was detonated at the surface of a level snow cover. For comparison, a 2-lb. block of tetrytol was detonated nearby. The blast and concussion from the Plastimite were noticeably inferior to that of the tetrytol. In contrast to the bright flash of the tetrytol, the Plastimite produced almost no flash. The Plastimite excavated a crater 4 ft. in diameter and 1-1/3 ft. deep. The tetrytol excavated an oval-shaped crater 2 ft. deep, with a mean diameter of $6\frac{1}{2}$ ft.

The following empirical formulas have been derived from blasting tests in winter snow covers:

$$R = k_1 W^{1/3} \quad \text{and} \quad D = k_2 W^{1/3}$$

where R = radius of blast crater in ft.
D = depth of blast crater in ft. } charge detonated on snow surface
W = weight of explosive in TNT equivalent, lbs.
k_1 & k_2 = constants depending on snow characterists, ft.-lbs.$^{-1/3}$

A 2-lb. tetrytol block is known to be the explosive equivalent of 2.5 lbs. of TNT. Thus the constants k_1 and k_2 can be determined for snow conditions prevailing at the time of the above test. Here, for the tetrytol crater, W = 2.5 lbs., R = 3.25 ft. (mean) and D = 2 ft. Solving for the constants, $k_1 = 2.4$ and $k_2 = 1.5$, and the formulas then read:

$$R = 2.4\, W^{1/3} \qquad \text{and} \qquad D = 1.5\, W^{1/3}$$

For the Plastimite crater, R = 2 ft. and D = 1.33 ft. Substituting these values in the above formulas, the TNT equivalent of Plastimite is found to be 0.58 lbs. for crater diameter and 0.70 lbs. for crater depth. Mean of these two figures is 0.64 lbs. TNT equivalent for a 2-lb. charge of Plastimite detonated at the snow surface.

Two-pound bags of Plastimite were used in routine, operational avalanche blasting. The subjective impression of the snow rangers using it was that Plastimite was definitely weaker than such customary explosives for this work as TNT or DuPont HDP. They felt a stronger blast would be preferred for reliable avalanche release.

On the basis of these tests, we recommend a minimum charge of 5 lbs. of Plastimite or similar nitrostarch slurry be used for avalanche blasting. This is equivalent to 1.6 lbs. of TNT in explosive energy, which our experience indicates is just barely adequate for routine avalanche blasting. For large slopes and hard slabs, a 10-lb. charge would be preferred for more reliable avalanche release.

The cost of even a 5-lb. charge of nitrostarch slurry is still about half that of a 2-lb. charge of commercial high explosives currently recommended

for avalanche control. There is an appreciable economy with the slurry, although a disadvantage is the extra weight which has to be carried in the field. On a blasting mission where a number of slide paths have to be blasted, this could be inconvenient. From the standpoint of stability, storage and handling properties, and convenience of arming with blasting caps, nitrostarch slurry is acceptable for avalanche control work.

It appears that nitrostarch slurry would also be acceptable for blasting cornices and for pre-planting charges either to remove cornices or to release slope avalanches. No tests have yet been made for these applications, but a further report will be issued as soon as data become available.